Chapter XI: Louisville District and Canalization

The funds provided for construction of locks and dams in the Ohio River Canalization Project from 1910 to 1922 were expended chiefly on structures upriver from Louisville. Construction of only three navigation structures on the Lower Ohio — Lock and Dam No. 41 at Louisville; No. 43 at West Point, Kentucky; and No. 48 below Henderson, Kentucky, not far from the site of the wing dam constructed by Colonel Long in 1826 — was completed before 1922, and serious problems were encountered in their construction. Above the Falls of the Ohio most locks and dams were constructed on rock and compacted gravel foundations; below Louisville such stable foundations were seldom available. Shifting sand foundations, recurrent flooding of cofferdams, short working seasons, and other problems so delayed construction that abandoning the slackwater project below Lock and Dam No. 48 was considered.

Few contractors were hardy, or "foolhardy," enough to undertake the projects below Louisville, But, through the leadership of such outstanding engineers as William H. McAlpine, construction methods to meet each exigency were devised by the Louisville District staff. In 1922 the big push to complete the canalization project to Cairo began on the Lower Ohio, and the Louisville District, which was also directing work on tributary streams and construction of a higher dam for both navigation and hydroelectric power production at the Falls of Ohio, became the "largest construction District" in the Corps. The slogan of the Ohio Valley Improvement Association was "On to Cairo by 1929," and the Louisville District met this goal.

Canalization Administration

Engineer officers stationed at Louisville, as elsewhere, reported directly to the Chief of Engineers until 1888, when the Corps decentralized administrative functions by dividing its program in the United States into five sections supervised by five Division officers. The Louisville Engineer District was first placed in the Northwest Division. Division Engineers were ordinarily senior officers with long experience, who at the beginning functioned as both District and Division Engineer, and the sole staff of the Division office was commonly a single clerk.[1]

The staff of Division offices gradually expanded, as Divisions were assigned project review, budgetary management, and comprehensive planning functions. On November 15, 1901, the Central Division, with offices at Cincinnati, was established to supervise Districts in the Ohio River Basin, then including Pittsburgh, Wheeling, First Cincinnati, Second Cincinnati, Louisville, Nashville, and Chattanooga Districts. After 1901 the Lousville Engineer District and other Districts became administrative entities with continuous records, no matter what staffing and project changes occurred, and all official reports and correspondence were channeled through the Central Division. The Central Division supervised operations in the Ohio Basin until the canalization project was completed in 1929. From 1929 to 1933 an effort was made to reduce administrative costs by consolidating several Division offices, but the system did not prove satisfactory. The Ohio River Division (ORD) was created on December 1, 1933, and it occupied the old Central Division offices in Cincinnati. ORD still

supervised Engineer operations in the Ohio River Basin in 1975.[2]

Improvement of the Falls of the Ohio, 1897-1914

From 1881 to 1901, 135,630 boats transporting cargoes aggregating 37,081,078 tons locked through the Louisville canal; the annual average was 6,780 boats and 1,854,053 tons. About 75 percent of this tonnage was coal; next in importance was lumber, followed by steel and iron products, sugar and molasses, salt, and agricultural produce. Traffic congestion was a major problem. On July 6, 1902, for instance, towboats pushing 461 barges arrived at the canal. By operating the canal full-speed around the clock, the canal staff completed 213 lockages to pass the coal fleet through by July 17.[3]

To enable coal-tow passage over the Falls and avoid the delays of lockage, rock excavation was undertaken at Indiana Chute at each low-water season prior to 1897, but this was an unsatisfactory process. A cofferdam was constructed in 1897 across the Indiana Chute to reveal the actual condition of the channel. The engineer in charge reported: "We have now an accurate knowledge of what has been done and what remains to be done, and in addition will be enabled to dispel the cloud of mystery which has for years made the Indiana Chute a terror to steamboat men." Sufficient excavation was accomplished to provide relatively safe navigation through Indiana Chute, and traffic continued to use the Chute at high water after Lock No. 41 was completed in 1921.[4]

The original timber-crib dam across the Falls, completed under the direction of General Weitzel in 1881, raised the pool above the Falls approximately three feet. A project to provide nine-foot navigation above the Falls to Madison, Indiana (the site of proposed Lock and Dam No. 40), was completed about 1910. The completed dam along the crest of the Falls consisted of eleven sections of Boulé gates, Chanoine wickets, and masonry weirs. The District Engineer commented in 1914: "No other movable dam of as great width or contending against such adverse conditions is known to exist anywhere. The work was therefore more or less experimental and in view of the knowledge available at that time is very successful." The project had one major defect: the piers separating the dam sections, instead of being flush with the upstream edge of the dam, projected 42 feet upstream from the dam to serve as icebreakers. The maneuver boats operating the movable dam sections experienced difficulties in moving around the piers and on several occasions went over the dam and Falls and were lost.[5]

Lock and Dam No. 41: Construction

The Lockwood Board, when planning the Ohio River Canalization Project in 1906, proposed raising the dam across the Falls, widening the Louisville canal to 170 feet to permit traffic to pass while in the canal, and constructing a new lock, No. 41 of the Ohio River series, with dimensions of 85 by 600 feet. Major Lytle Brown, Louisville District Engineer, pointed out that the 85-foot wide lock would be the only one on the Ohio with less than the standard 110-foot width. He suggested that the Louisville lock be also 110-feet wide and the canal prism be widened to 200 feet, predicting that these changes would avert the "bottleneck" sure to develop when inland marine engineers designed floating equipment for the standard 110-foot wide Ohio River lock. The Secretary of war approved Major Brown's suggestions in 1911, and con-

struction of a standard Ohio River lock on the southwest side of the old double-lift Weitzel lock began in 1911.[6]

The Merrill rolling-gate had been used on locks on the Upper Ohio because of the engineering problems of constructing satisfactory mitering-gates for a 110-foot wide lock chamber. Rolling gates had several operational defects — the tracks and wheels required expensive maintenance and the gate recesses were badly silted up in high water. At Lock No. 37 just below Cincinnati, for instance, the lock recesses were filled with 2500 cubic yards of silt by the record flood of 1913. This was serious, for it required 28 days of round-the-clock work to get the lock back in operation. The problem of designing satisfactory 110-foot-wide mitering-gates was solved at Lock No. 41 by the Louisville District engineering staff — Principal Engineer William H. McAlpine, Assistant Engineers Paul Grunwell, Whitney I. Gergory, Frank I. Louckes, Robert A. Strecker, and Malcolm Elliott. Malcolm Elliott had charge of gate design, and the improved gates were chiefly the results of his work. Elliott later accepted a commission in the Corps of Engineers and became first District Engineer at Huntington, West Virginia, District in 1922.[7]

Construction of Lock No. 41 and enlargement of the Louisville canal were plagued by delays and accidents. The flood of 1913 filled the excavations with silt and debris, and recurrent floods substantially delayed progress. The lock contractor (Ohio River Contract Company) failed in 1915 and went into receivership; and during the first World War, 1917-1918, great difficulties were encountered in employing labor and purchasing materials. The old canal continued in service during enlargement, with a portion of the rock ledge and old stone-masonry wall serving as a cofferdam between the old canal and the excavation. On October 5, 1915, a section of the old wall and rock ledge collapsed, releasing a wall of water into the new excavation. Work was then underway about 3,000 feet from the break, and locomotive and boat whistles gave warning. Before the water hit the work site, all workers, save one who drowned, managed to scramble out of the excavation. Floods, accidents, contractor failure, and limited funding delayed the opening of Lock No. 41 till May 1, 1921.[8]

Power Development at the Falls

While Lock No. 41 was under construction, interest in developing potential hydroelectric power at the Falls of the Ohio was increasing. To produce hydroelectric power economically it is necessary that adequate water and fall, or "head," be available a substantial percentage of the time. The movable dams of the canalization project seldom had sufficient "head" for commercial power production, but the Falls of the Ohio had been used to power water mills for many years and hydroelectric power production appeared feasible.

Perhaps George Rogers Clark was the first to recognize the water-power potential of the Falls; in 1807 he sold property on the Indiana side for the construction of a water-powered flour mill. The Tarascons of Shippingport erected a six-story flour mill powered by water wheels about 1815; the Army Ordnance Department considered constructing an armory at the Louisville Canal in 1823 to take advantage of available water power; water mills to crush limestone into Louisville hydraulic cement operated at the Falls until 1892; and the Ohio Falls Hydraulic and Manufacturing Company operated a large flour mill near Jeffersonville until 1902. When their flour mill burned in 1902, the Ohio

Falls Company developed plans for a million-dollar dam across the Falls to maintain a pool level of 12.7 feet at low water and facilitate power production.[9]

Major George McC. Derby, Louisville District Engineer, strongly supported the company's plans in 1903, pointing out that such a dam would provide a long slackwater pool for navigation and that improvements in electric power transmission made such a project feasible. He predicted:

> The construction of a dam at Louisville that will make this water power available for commercial purposes is a probability of the near future that should be reckoned with in connection with the improvement of navigation, the more so as the two interests need not necessarily conflict with each other, but, on the contrary, might readily be so adjusted as to be mutually advantageous.[10]

But the company never matured its plans and the subject was dropped until 1912, when District Engineer Lytle Brown (Chief of Engineers, U. S. Army, 1929-1933) and his chief assistant, William H. McAlpine, restudied the project. Major Brown published several articles in engineering journals which clearly demonstrated that improved low-head hydroelectric turbines and the growing industrial market at Louisville made the development of power at the Falls of the Ohio practicable. The Army Ordnance Department studied the Falls in 1917 as a possible location for nitrate plants for munition production, but eventually selected sites near Muscle Shoals on the Tennessee River.[11]

District Engineer George M. Hoffman reviewed the power situation at the Falls in 1920. He found that a coal-shortage, chiefly caused by traffic congestion on railways during and after the war, had multiplied the price of coal and the power produced at steam-electric plants. Louisville also suffered annual losses of three million dollars as a result of coal-smoke air pollution. Colonel Hoffman believed that these problems could be alleviated and Ohio River navigation could be benefited by the construction of a higher, combined power and navigation dam at the Falls, which reduced the costs of the canalization project by eliminating the necessity for constructing proposed Dam No. 40 at Madison, Indiana.[12]

The existing dam at the Falls in 1920 was designed to maintain an upper pool elevation at 412 feet, providing a minimum depth for navigation upriver to the proposed site of Dam No. 40. In 1921 the Louisville District initiated planning to raise Dam No. 41 to furnish a stable pool eight feet deeper; that is, to raise the upper pool to elevation 420, thereby eliminating Dam No. 40. The District also publicized the fact that the higher pool elevation would provide sufficient "head" for economic production of secondary hydroelectric power.[13]

After Major Lytle Brown had published his study of the power potential at the Falls in 1912, John William Link, Hydraulic Engineer for Byllesby Engineering and Management Corporation, of which Louisville Gas and Electric Company was a subsidiary, had begun studies of the project. Byllesby Engineering organized the Louisville Hydro-Electric Company and in 1923 applied to the Federal Power Commission (FPC) for a license for a power project connected to Dam No. 41. Municipal authorities of Louisville also became interested in the project, employed Major General William L. Sibert to make the engineering studies, and applied for a license.[14]

General "Goliath" Sibert had left the Ohio Valley in 1907 to join General George W. Goethals (who, like Sibert, had

acquired his first civil works experience in the Ohio Valley as assistant to Colonel Merrill) in completing the Panama Canal. General Sibert had served as first Chief of Chemical Warfare Service during the First World War and returned to the Green River Valley in 1920, settling at Bowling Green to pursue his fox-hunting hobby and a career as consulting engineer during retirement.[15]

Because Louisville would have had to build its own power distribution lines, or take over the Louisville Gas and Electric Company through condemnation proceedings, and in either case would have exceeded its bonding limitations, the FPC awarded the license for power development at the Falls to Byllesby Engineering on December 4, 1923. Construction of a new dam and powerhouse on the Falls began in 1925 and was completed in late 1927. New Dam No. 41 was an "L" shaped structure, eight feet higher than the old dam and 8,652.6 feet long, consisting of 3,832 feet of fixed dam, 3,740.6 feet of movable Boulé dam, 220 feet of bear-traps and bear-trap piers, and 860 feet of Chanoine wicket navigable pass. The concrete powerhouse had eight turbine power units, with 108,000 horse-power capacity. After testing, power production began on October 10, 1927, and the low-head turbines performed well. In fiscal year 1931, for instance, power production was suspended because of lack of "head" for only nine days and total production amounted 257,467,300 kilowatt hours.[16]

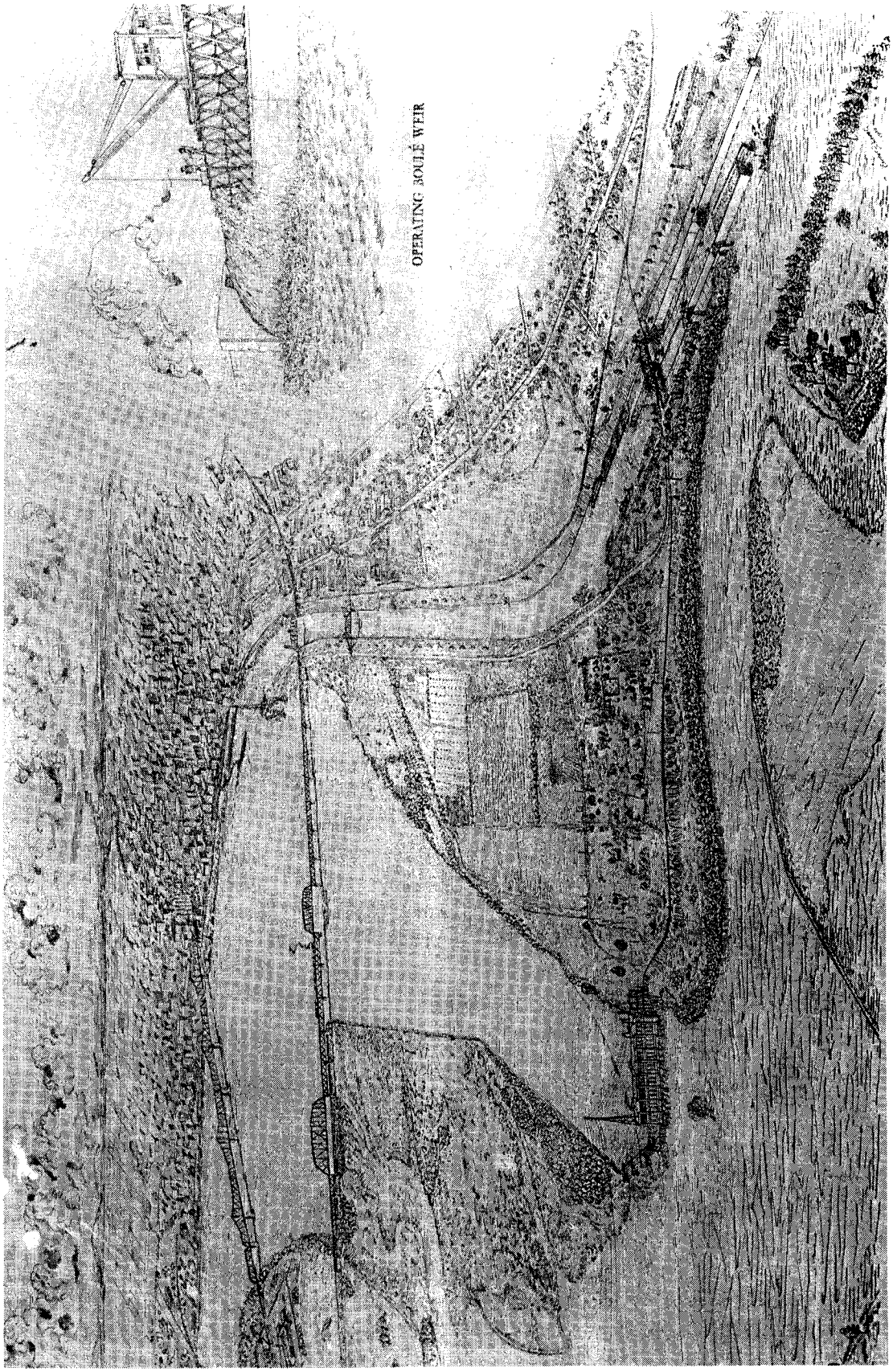
Nadir of Ohio River Commerce

By 1917 the waterborne commerce which the Ohio River Canalization Project was designed to serve had practically come to a halt. The steamboat packet and freighting business dwindled throughout the first quarter of the twentieth century, and in 1916 the historic shipment of coal from Pittsburgh to New Orleans abruptly ceased. Waterborne commerce on the Ohio reached a low in 1917 of 4,598,875 tons. Colonel Thomas P. Roberts, who had participated in the survey of the Ohio River just after the Civil War and who had become an Assistant Engineer in the Corps, said in 1923: "At present the Ohio is, to a considerable extent, only a playground for owners of small locally owned boats engaged in a short-distance transportation."[17]

The transportation needs once served by the steamboat packets ceased to exist in the twentieth century, but a few packets continued to eke out a business until the Depression of the 1930s. The end to the Pittsburgh to New Orleans coal trade was more sudden. The Monongahela River Consolidated Coal and Coke Company, or the "Combine," including nearly every coal shipper in the Pittsburgh area, had been formed in 1899, and by 1906 it owned and operated 80 towboats and 4,000 barges and coalboats, moving about 1.2 million tons of coal annually to New Orleans. But the need for coal of the steel industry of the Upper Ohio Valley, competition from Alabama coalfields and Oklahoma oil in the New Orleans market, and major losses of floating plant on the unimproved Lower Ohio and Mississippi rivers led the Combine management to the decision to end the coal trade on the Ohio in 1916. Thus, in one stroke, fifty percent of the total waterborne commerce on the Ohio was taken from the river.[18]

Colonel William W. Harts, Central Division Engineer, said in 1923:

> The supreme test of the public value of any inland waterway must always be an economic one. Can the actual ton-mile cost to the shipper of hauling by barge and towboat, or by other similar means, when added to the ton-mile cost of interest



Drawing showing the combined navigation and hydro-electric development at the Falls of the Ohio at Louisville, Kentucky.

> on the first cost, depreciation, and maintenance of the water-way now borne by public taxation, effect, when combined a savings over other means of transportation?[19]

Estimates of the ton-mile costs on the Ohio River, after the end of the long-haul coal trade, were not favorable, for the overhead costs on the canalization project were relatively fixed and diminishing traffic resulted in a relative increase in costs per ton-mile. Costs of the canalization project were calculated in 1922 at 13.4 mills per ton-mile. Adding the 5 mills per ton-mile charge of the carriers led to the conclusion that freight moved on the Ohio at 18.4 mills per ton-mile. When compared to prevailing railroad rates of 13.9 mills per ton-mile, the Ohio River Canalization Project appeared to be a poor investment.[20]

Frank A. Alfred, a railroad official, asserted:

> It does not seem likely . . . that the completion of the improvement project will result in a considerable increase of river traffic. Coal which formerly went from Pittsburgh to New Orleans is now obtained from Tennessee and Alabama, partly by rail and partly by water. The sand and gravel business is purely local and would have existed in about its present volume if no improvements had been made. In the light of present experience, one is forced to the conclusion that the construction of these works was an economic waste. The Ohio is the one river in the United States on which there seemed to be a fair prospect of developing a large and important traffic. These great expectations have not been realized and the writer feels it must be admitted that the experiment is a failure.[21]

The Corps still predicted that, in the end, the project would be successful. Major Malcolm Elliott, former Assistant Engineer in the Louisville District, compared the Ohio River Canalization Project to a railroad under construction from Pittsburgh to Chicago which was completed only to Fort Wayne. It could not be a paying proposition until completed. And William M. Hall, Assistant Engineer on the canalization project, questioned the necessity for computing the economics of the project:

> The Government is now spending money many times as much for highways and National paved roads as for rivers and harbors. No such test as that referred to seems to have been suggested as a condition for that expenditure. Why, then, should such a test apply and be the final criterion for river improvement any more than for public highways for automobiles, horse, and pedestrians from which no revenue is received or expected except in the way of National prosperity and the tax thereon?[22]

In this atmosphere of doubt of the project's efficacy and predictions of dire failure, Congress expressed its faith in the capability of the Corps and its belief that waterways transportation had a future in the United States by making substantial appropriations for rivers and harbors in 1922 and in subsequent years. To avoid falling again into the "pork barrel" pit, it assigned the total appropriations to the War Department for allotment to projects according to their merits, and the Ohio River Canalization Project was given large shares to expedite its completion. The slogan popularized by the Ohio Valley Improvement Association was: "On to Cairo by 1929! "[23]

Largest Construction District of the Corps

The First Cincinnati Engineer District continued to administer the old open-channel project on the Ohio until 1929. Construction of the locks and dams was assigned to Pittsburgh District, from the head of the river to Steubenville, Ohio (Locks and Dams. Nos. 1-10); Wheeling District, from Steubenville to Huntington, West Virginia (Nos. 11-28); Second Cin-

cinnati District, from Huntington to Madison, Indiana (Nos. 29-40); and Louisville District, from Madison to the mouth of the river (Nos. 40-54). Prior to World War I, the District Engineers participated in the Ohio River Board centered at the Wheeling office, which worked out standard designs for the locks and dams and studied related problems, but after the war most construction was in the Louisville District and the Ohio River Board suspended its meetings.[24]

In 1922, as active construction ended on the Upper Ohio, the Wheeling and Second Cincinnati Districts were consolidated in an Engineer District at Huntington, West Virginia, and the First Cincinnati District was assigned a section of the canalization project. The Louisville Engineer District, after 1922, was constructing and operating twelve locks and dams on the Ohio in addition to its projects on tributary streams and the new dam at the Falls of the Ohio. A. G. Wakefield, Chief Clerk of Louisville District, 1924-1945, claimed that during the 1920s the Louisville District was the "largest construction district in the United States." It is a fact that Nicholas Longworth, Majority Leader of the House of Representatives, heard a rumor in 1925 that Louisville and Cincinnati Districts were to be consolidated and asked the Chief of Engineers if it were true. The Chief replied that the Louisville District had such a workload, that if any change at all were made it would be to subdivide it into several Districts.[25]

Construction of Locks and Dams Nos. 43 and 48

Locks and Dams Nos. 41, 43, and 48 were first selected for construction in the Louisville District. The Ohio River Contract Company was awarded the contract for Nos. 41 (at Louisville canal) and 48 (near Henderson, Kentucky) in 1911. The firm failed in 1915 and the projects were completed by subcontracts let by the receiver. The Louisville District recommended in 1913 increasing lock-lifts and relocating proposed dam-sites to eliminate a lock and dam between Nos. 41 and 48 to reduce costs, and, after study, proposed Lock and Dam No. 42 was deleted from the project.[26]

All locks and dams constructed above Louisville rested on rock or compacted gravel formations; below Louisville almost every lock and dam would have to be constructed on unstable sand and gravel. Potential contractors refused to bid on the lower river projects, saying it would be "impossible" to construct impervious cofferdams on such a foundation. As a result, most locks and dams on the Lower Ohio were completed by the District staff with hired labor.[27]

And the troubles experienced in constructing Locks and Dams Nos. 43 and 48 were not encouraging. Ohio River Contract Company, the sole bidder, was awarded the contract for No. 48 in 1912. The project was flooded and heavily damaged by the near-record flood of early 1913. Then on July 21, 1913, a cofferdam "blew out." Four loaded coal barges, a barge of lumber and a barge of piles were drawn through the break and rolled over and over, destroying much of the contractor's equipment. There were no bidders for construction of No. 43, and the District undertook the work with hired labor. Records of work at the project in late 1914 and early 1915 indicate some of the problems experienced: on October 16 cofferdams were flooded; they were pumped out and work resumed October 21. They were flooded again December 9, pumped out on December 17, and flooded again on December 22. Work resumed

April 28, 1915; the cofferdam was flooded on May 27; pumped out on June 18; flooded on June 19; pumped out again June 24.[28]

In 1918 the worst ice conditions of record on the Ohio River hit the projects. James F. Nutty, Chief Clerk, telegraphed the President of the Mississippi River Commission and requested aid in retrieving the floating equipment descending the Ohio in the ice gorge. It included all the contractor's floating plant from Dam No. 48, most of the government floating plant from Dam No. 43, plus fifty coal barges, a towboat, and hundreds of miscellaneous watercraft. Most of the government vessels were eventually retrieved, but the contractor at No. 48 lost equipment valued at $50,000. As a result of floods, ice gorges, cofferdam problems, and other delays, No. 48 took eight years, 1913-1920, to complete, exceeding the original contract time limit 100 percent. No. 43 took seven years, 1914-1920.[29]

These difficulties created doubt about the future of the project and study began in 1918 of eliminating all locks and dams of the series below No. 48 and maintaining the channel by dredging. The Louisville District found that a nine-foot depth could not be maintained economically by open-channel work. To lower project costs, it designed Chanoine wickets twenty-feet long for the lower river and relocated the dam-sites to eliminate one lock and dam, renumbering the structures to delete number 54 of the series.[30]

Construction Methods

Construction on the Ohio was, and is, subject to many difficulties not encountered on dry-land projects. Floods frequently arrived unexpectedly, topping cofferdams, injuring equipment, destroying completed work, and burying the work under tons of silt. Work was ordinarily suspended during bad weather and high water seasons; on this account, contractors were often allowed a certain number of "fair working days" to complete a project. Delays and accidents beyond the control of the contractor were usually considered ample reason for extending contract time, but contractors assumed all risk to the equipment and unfinished construction. And this was why few contractors were interested in bidding on the locks and dams below Louisville.

Since most project sites on the lower river were distant from large towns, the first step, after land acquisition was complete, was to construct quarters for hired labor — usually consisting of an office, a warehouse, a machine and blacksmith shop, a cement shed, a mess hall, bunk houses, family quarters, and a small power house. At Dam 50 (near Cave-in-Rock) quarters for 300 workers were constructed; at Dam 46, near Owensboro, no quarters were required. On the Upper Ohio the cost of a lock and dam had been estimated at $1,200,000 where the river was 1200 feet wide, adding $400 for each additional foot of width, and actual costs approximated these estimates. On the Lower Ohio, the isolated locations of most structures and the shorter working seasons because of high water increased costs. The rule-of-thumb used by Principal Engineer William H. McAlpine for each lock and dam was $500,000 for preliminary work; $1,200,000 to $1,400,000 for lock construction; $700 per linear foot of dam; and about $150,000 for contingencies.[31]

William H. McAlpine, the Principal Assistant Engineer of Louisville District, 1912-1930, supervised most construction on the Lower Ohio. Mr. "Mac" as he was known to his colleagues, was an 1896 graduate of Massachusetts Institute of

Technology. He began his service with the Corps on the Kentucky River in the Cincinnati District in 1902. Mr. Mac directed design and construction of locks and dams on the Upper Mississippi River from 1930 to 1934, then became Chief of Engineering Division, OCE, serving as consultant on scores of flood control, hydroelectric, navigation, and multipurpose projects. In 1946, Mr. Mac was recognized as "foremost in his field," and by permission of Congress was appointed Special Assistant to the Chief of Engineers, senior to all other engineers in the Corps.[32]

When the Louisville District Engineer learned that Mr. Mac had been offered a lucrative position with a private firm in 1916, he urgently recommended an increase in salary, declaring that Mr. Mac's services would save the United States a hundred thousand dollars on each lock and dam completed on the Lower Ohio. Mr. Mac stayed with the Corps and completed some fifty-four years of service to the nation before his death in 1956.[33]

One of the engineering problems Mr. Mac and the District staff solved on the Lower Ohio was building locks and dams on a sandy foundation. The solution chiefly consisted of driving round timber piles, ordinarily about thirty feet long, to the rock substrata, and building the concrete foundation for the lock or dam structure around the tops of the piles. Wooden and, later, interlocking-steel sheet piling was driven down on the upstream side of the structure to form a curtain protecting the foundation. Riprap stone was placed on the downstream side to prevent scour and further stabilize the structure. Only one foundation failure was experienced during construction of the canalization project, and that was at Dam No. 26 on the upper river where a weak shale foundation slid laterally.[34]

Cofferdams, usually in three sections to hold out the river while the site was excavated, piles driven, concrete poured, and movable wickets installed, also presented a problem. The first cofferdams used on the canalization project were the "Ohio River box type" — wooden box frames about twenty feet wide and sixteen to twenty feet high, which were dropped into the river in sections side by side and filled with sand by dredges. No effort was made to keep them completely watertight, and powerful pumps served to keep the working area within the coffer reasonably dry. Steel cofferdams, of interlocking-steel piling filled with dredged materials, were first used by the Corps in raising the battleship Maine from Havana harbor, and they came into use on the Ohio about 1917. They were not used extensively on the Lower Ohio, however, because Mr. Mac did not think their advantages outweighed the difficulty and expense of removing the piling after work was completed.[35]

Sand and gravel aggregate for concrete was dredged from the riverbed. Some mixing plants were placed on and in the cofferdams, and the concrete was distributed to the forms in buckets on small flat cars hauled by tiny locomotives, or by cables attached to a stationary engine. Floating mixers were used on occasion, and at Dams Nos. 45 and 46 Assistant Engineer H. G. McCormick used a plan for placing concrete through chutes from a movable concrete mixer mounted on rails.[36]

One particularly interesting development was the application of "Taylorism," or efficiency engineering, to the Ohio River project in 1915. Uniform cost-keeping accounting had previously been applied to shop and office management; Lieutenant Stuart C. Godfrey, mathematics professor at West Point, was assigned

MISTER "MAC"—William H. McAlpine

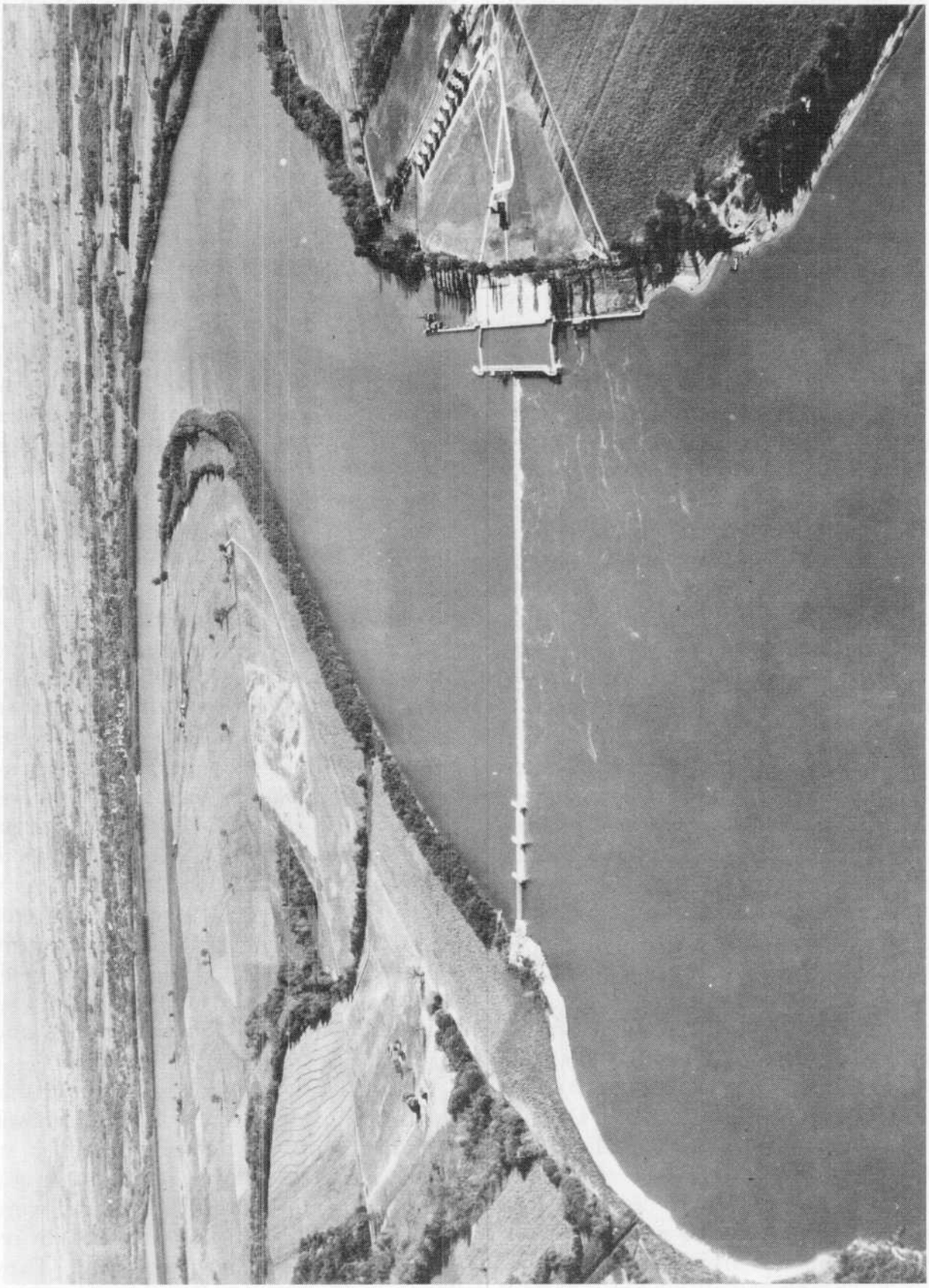
to various construction sites on the Ohio in the summers of 1912-1917 to apply cost-keeping and efficiency management to field engineering. At such projects as Dams Nos. 39 and 43, the new accounting system made it possible to make available to project engineers the precise costs of a day's work by 9:00 a. m. the following morning. Reaction to the system was mixed, however. Captain Henry A. Finch, project engineer at Dam No. 39, believed the savings derived from the cost-keeping efficiency system were less than the cost of the system itself, and asserted that common sense combined with close personal observation by the engineers in the field was more economical and equally as effective as the new system.[37]

The experimental work of Lieutenant Godfrey foreshadowed, however, a type of engineering which was to be applied to civil works by the Corps nationally. Lieutenant Godfrey also applied the system to combat engineering; he received a commendation from General John J. Pershing during the First World War for constructing a 1,440-foot pontoon bridge in 58 minutes, 30 seconds. Godfrey later served as Chief of Finance Division, OCE, and in 1941 became Engineer of General Headquarters, U.S. Army Air Force, in which capacity he organized and led the first airborne aviation engineers.[38]

The problems with operation of the Merrill rolling-gates have been previously discussed. The vertically framed mitering-gate constructed of structural steel and operated by a hydraulic oil cylinder and piston, designed in the Louisville District in 1913, became standard on the Ohio River. They opened and closed more swiftly with a single stroke of the piston, required less than half the power to operate, and eliminated the troublesome gate recesses. The Chanoine wickets used at Davis Island, but increased in length to twenty feet, remained standard for the navigable pass in the lower river; however, the navigable pass at Davis Island (No. 1) was 559 feet wide, as compared with 1,248 feet at Dam No. 53. The bear-trap weir, installed at Davis Island in 1891, was standardized on the lower river at two weirs, each 91 feet long, between masonry piers. The lower leaf was made entirely of steel and the upper leaf was a steel frame with wooden filler. The remaining weir capacity was either Chanoine wicket or movable Bebout wickets (designed by Assistant Engineer Guy B. Bebout of Wheeling Engineer District).[39]

To meet the goal of completing the project to Cairo by 1929, the work in the Louisville District was carried on with some urgency from 1927 to 1929. Construction of the last structure of the series, Lock and Dam No. 53 below the Grand Chain, began with the construction of a camp for workers in 1924. No. 53 included the standard Ohio River lock, a 1,248-foot wide Chanoine navigable pass, two standard bear-trap weirs, and Chanoine and Bebout weir sections, the latter maneuvered from a trestle. The construction of No. 53 was pressed forward 24 hours a day, seven days a week when water stages permitted. The largest inland suction dredge in the world, the *C. B. Harris*, with a thousand-yards per hour capacity, was brought in to make the excavations and fills.[40]

All workers were facing the inevitable reduction in force when the project was completed, but to finish the project in 1929 it was necessary to keep morale at a high pitch and relatively high wages were paid. But hard work was expected in return. One worker later recalled: "They drove us like mules. Didn't matter how



Lock and Dam 49 on the Ohio River. This was typical of the original low-lift structures built as part of the Canalization of the Ohio.

hard it rained. We worked. Nor how cold it got. We worked." Major W. W. Gruber, an Assistant Engineer on the canalization project, wrote a poem in 1929 about his experiences, which read, in part:

Now the Chief wants both gates finished
An' the coffers torren out,
An' the jacks and sectors 'spended
So's to concrete round about;
The pipe lines must be coupled
An' the valves put in their place,
The turbine swung into its pit
An' set to run its pace,
An' he wants them rocks unloaded,
Them as weighs ten ton or more
An' he told us to dig gravel
So's that concrete we can pour;
Now we can't do much with nothin'
'Til its fixed so's it won't sink,
But the derrick boats is busted
An' the highline's on the blink.

Then you're pluggin' like the devil
Day an' Sunday an' at night,
An' you do your level damndest
Just to get things goin' right;
Then the Big Chief comes a lookin'
Just to find all fault he can,
Sees a derrick boat is idle,
Says this crew ain't worth a damn,
He could do the job much better
An' with half the time and men,
If he only wasn't busy
In the office now and then.
Well I'd like to see him do it
With this worn out Army junk,
When the derrick boats is busted
An' the highline's workin' punk.[41]

Completion Ceremonies, 1929

Lock and dam No. 53 was completed on August 27, 1929, and the Ohio Valley Improvement Association joined with other river interests in organizing a project Dedication Cruise from Pittsburgh to Cairo in October, 1929, signaling the completion of the Ohio River Canalization Project at costs of about $125,000,000. A flotilla of packets departed Pittsburgh on October 18. Pilots of the flagship, the *Cincinnati*, were Captain James H. Rowley (nephew of George Rowley) who had participated in the Davis Island Dedication ceremonies in 1885, and Captain Jesse P. Hughes, who had piloted a boat at the dedication of the second lock and dam, No. 6, completed in 1904. Among the crowds of congressmen, Corps officials, and representatives of commercial interests, were James Milnor Roberts, grandson of William Milnor Roberts, and Major General "Goliath" Sibert. Crowds gathered at riverside to wave at the passing packets, and sirens, bells, whistles, cannon salutes, and brass bands greeted the fleet at every stop.[42].

President Herbert Hoover, a professional engineer, joined the cruise at Cincinnati on October 22. He unveiled a commemorative monument at Cincinnati, and in his address to the crowd expressed his regret that Colonel William E. Merrill and others who had initiated the project had not lived to see its completion. The President boarded the *Greenbrier* for the trip to Louisville, and as the boats passed Madison, Indiana, there was a grim reminder of the Davis Island celebration of 1885. A soldier was killed by a premature explosion of powder while firing a salute. President Hoover landed at Louisville on October 23, addressed a crowd at Louisville Auditorium, and his speech showed a remarkable sensitivity to the historic aspects of the occasion:

> While I am proud to be the President who witnesses the apparent completion of its improvement, I have the belief that some day new inventions and new pressures of population will require its further development. In some generations to come, they will perhaps look back at our triumph in building a channel nine feet in depth in the same way that we look at the triumph of our forefathers when, having cleared snags and bars, they announced that a boat drawing two feet of water could pass safely from Pittsburgh to New

> Orleans. Yet for their times and means they, too, accomplished a great task. It is the river that is permanent; it is one of God's gifts to man, and with each succeeding generation we will advance in our appreciation and our use of it. And with each generation it will grow in the history and tradition of our Nation.[43]

The President left the cruise at Louisville, and the cavalcade continued on to Cairo. At Lock and Dam No. 53, General "Goliath" Sibert, who had so much to do with the adoption of the nine-foot project in 1910, addressed the crowd, and then a satin ribbon stretched across the lock was cut and the fleet locked through. It reached Cairo and landed on October 29, 1929, and after sunset the *Cincinnati* departed on the return trip to the sound of a band playing "'Till We Meet Again." The band should have played "Taps," for October 29, 1929, was the day of the resounding crash on Wall Street, which, in addition to many other effects, brought a rapid end, except for historic relics, to the steamboat packet business.[44]

Conclusion

Both friends and foes of the Ohio River Canalization Project had looked forward to the completion of the project in the belief that its operation would provide conclusive support for their respective views. The editor of *Engineering News-record* commented in early 1930 that only a great increase in traffic on the Ohio would justify the public investment, and that all future investments in waterways projects should depend, very largely, on the success or failure of the project.[45]

The canalization project had cost only about a third as much as the Panama Canal, but had taken twice as long to complete. Senator James E. Watson of Indiana, member of Congress, 1895-1933, had these thoughts on the reasons for the slower progress on the Ohio:

> The Ohio River . . . always has been counted a necessary project, and . . . numerous appropriations were made for this lock or that dam, until, covering a long series of years, a work that should be consummated in a decade, has at last been finished. When a River and Harbor bill came before Congress in the old days we had to appropriate for enough rivers to get enough legislators to carry it through, for if we didn't and the outsiders would outnumber the insiders, they would start to amend the bill, and it would be amended until we would run counter to the President's wishes and meet with executive inter-position. We had to appropriate money enough to get enough people interested to pass the bill, and no matter how meritorious a proposition might be, if we didn't have votes enough, it was lost. I have voted to appropriate money to improve rivers that should have been macadamized for highways . . . I hope that day has passed in the American Congress . . .[46]

Completion of the nine-foot project came far too late to aid the steamboat packet and freighting business, and, somewhat ironically, the barge-towing interests who had opposed the project at its inception were the chief recipients of the benefits of the project. Though the long-haul coal trade to New Orleans had ended in 1916, a short-haul trade continued and, as steam-electric plants were constructed at riverside, began to grow. Construction of steel-hull barges and boats, for use chiefly on the Monongahela, began about 1910 in the Ohio Valley. In October, 1921, Jones & Laughlin Steel Corporation of Pittsburgh loaded 4,000 tons of steel products in steel barges, moved them down the Ohio and Mississippi, and saved a tidy sum thereby. The company began regular shipments, and was soon emulated by Carnegie Steel, American Bridge, Inland Steel, Wheeling Steel and other corporations. This new traffic and the support of the corporations for rapid completion of the canalization project was doubtless a great aid to the proponents of the project

in Congress.[47]

The shipment of petroleum products in steel tank barges also reached a significant proportion in the 1920s; the amount shipped down the Ohio to markets in the Mississippi Valley reached 100,000 tons in 1925. Private carriers, owned by steel, petroleum, and other corporations, transported 95 percent of the commerce on the Ohio in 1926, but as the canalization project neared completion the American Barge Line of Louisville, a common carrier, began operations with 50 steel barges and three Diesel towboats.[48]

The first returns on the public investment in the canalization project did not appear promising — tonnage fell to a Depression low of 14 million tons in 1932. But by 1939 tonnage was roughly 26 million tons; ton-mileage, indicating movement of cargo longer distances, was double that of 1929; and steel and petroleum, neither of which moved via the Ohio to any appreciable extent prior to 1929, ranked second and third behind coal in tonnage. The Lockwood Board had predicted in 1906 that a nine-foot project on the Ohio would produce transportation savings of $2,280,000 annually; estimated savings by 1939 were several times that figure.[49]

Perhaps more important to the average citizen of the Ohio Valley was the fact that transportation savings enabled producers to make a greater profit which was passed on by the producers to the consumers to the disadvantage of competitors, but to the benefit of the public whose taxes had funded construction of the Ohio River Canalization Project.